Astrophysical Phenomena Revealed by Space VLBI
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The Green Bank Telescope: An Overview

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Abstract

The 100 m NRAO Green Bank Telescope (GBT) will be completed in early 2000. The GBT has a large number of unique design and performance features that give it unprecedented scientific capability. We review those features, which include an offset feed (clear aperture) design, an active surface, broad frequency coverage from 100 MHz to 115 GHz, a versatile receiver selection mechanism, and a new multi-input, 256k-channel autocorrelation spectrometer.

1 Introduction

The Green Bank Telescope (GBT) will be among the most advanced and versatile telescopes ever constructed. The GBT, shown in Figure 1, will be completed in the summer of 2000. The GBT is a 100 m radio telescope with an unblocked aperture, fully active surface of 2004 individual panels, and laser metrology system for surface settings and pointing corrections. The GBT will operate over a wavelength range of 3 meters to 3 millimeters. Its collecting area is 7853 m^2, it stands 146 m high, and has a moving weight of 7700 metric tons. Although one of the largest moving structures on earth, it will ultimately have 1 arcsec

Table 1: GBT Operating Specifications

Parameter	Constraint	Specification
Surface accuracy	Open loop surface	$<$ 360 μm (rms)
	Closed loop/metrology	$<$ 220 μm (rms)
Pointing accuracy	Conventional	3 arcsec (rms)
	Closed loop/metrology	1 arcsec (rms)
Slew rate	Maximum Azimuth	40 deg/min
Beam size	Nominal FWHM	720 $arcsec/\nu$ (GHz)
Flux sensitivity	at 20 GHz	1.85 K/Jy

Figure 1: Image of the GBT on 2000 January 21.

pointing accuracy and will allow observations at 3 mm wavelengths. A summary of GBT design features follows.

The NRAO in Green Bank has supported the VSOP mission with both 140 foot telescope observations and a ground tracking station for the HALCA satellite (Hirabayashi et al. 1998). The great collecting area of the GBT will valuable for future space VLBI observations requiring high sensitivity.

The GBT's characteristics (Table 1) will allow its users to address a wide range of scientific topics over a wavelength range of meters to millimeters (Tables 2, 3), including observations of young galaxies at extreme redshifts, pulsars, HI and molecular spectroscopy, ground and space VLBI, and millimeter-wave spectroscopy and continuum studies.

2 Construction and Commissioning

As of mid-February 2000, all antenna structural components were completed and over 80% of the surface panels were installed. Most of the remaining work is expected to be completed in the Second Quarter of 2000, and we anticipate that the telescope will be available for the start of commissioning in the Third Quarter. Most NRAO systems, including receivers, backends, peripheral electronics, monitor and control software, and basic analysis software will be available when commissioning begins. Pointing and surface calibration and commissioning of basic systems and low frequency receivers is expected to take about 6 months. Commissioning to 50 GHz will take another 6-9 months. Operation in the 3 mm window should be available by the end of 2001.

Table 2: GBT Receivers

Receivers	Operating Range	Status
Prime Focus 1	290 – 920 MHz	Completed
Prime Focus 2	910 – 1230 MHz	Under Construction
L Band	1.15 – 1.73 GHz	Completed
S Band	1.73 – 2.60 GHz	Completed
C Band	3.95 – 5.85 GHz	Completed
X Band	8.20 – 10.0 GHz	Completed
Ku Band	12.4 – 15.4 GHz	Completed
K Band	18 – 26.5 GHz	Completed
Ka Band	26 – 40 GHz	Planned
Q Band	40 – 50 GHz	Under construction
W Band	68 – 90 GHz	Proposal stage
	90 –115 GHz	Proposal stage
Bolometer Camera	3 mm band	Planned

3 Observing with the GBT

Much of the year 2000 will be devoted to completing and commissioning the GBT, but it is anticipated that some visitor observations will begin during the year. The first observations will be at the lower frequencies, and will allow, for example, HI and OH spectroscopy and pulsar projects. Toward the end of 2000 or in early 2001, frequencies approaching 50 GHz may be available. This will open up a range of projects that are not possible with current facilities. The first call for observing proposals is anticipated for the spring of 2000. The observing community will be notified of the dates and parameters of the first call for proposals by e-mail, newsletters, and Web announcements on the NRAO Green Bank home page (http://www.gb.nrao.edu).

Table 3: GBT Spectrometers, Continuum, and Pulsar Backends

Backend	Specifications	Status
GBT Spectrometer	Maximum channels/IF: 262,144	Integration
Modes:	8×800 MHz or 32×50 MHz	
Pulsar:	4096 $time\ bins \times 256\ channels$	
Spectral Processor	2×1024 channels (40 MHz)	Completed
	1, 2, 4, or 8 IF modes	
Digital Continuum	16 inputs, 10 switching phases	Completed
	100 nanosec phase time resolution	
VLBI	VLBA, VSOP and S2 Recorders	Integration

4 Future Development Plans

The GBT will begin operations with excellent performance specifications and a powerful suite of instrumentation. The scientific capability of the GBT can be further exploited by the additional development of observing instrumentation and computing capability. Possible projects include enhanced pulsar backends, focal plane array receivers at several frequencies, pipeline data processing, dynamic scheduling, and remote observing capability. Particularly exciting is the potential of the GBT in the 3 mm band, where it will have unparalleled sensitivity. Receivers for point source observations (line and continuum), spectroscopic focal plane arrays, and large-format bolometer cameras for continuum observations in the 3 mm window are being investigated.

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References

Hirabayashi, H., Hirosawa, H., Kobayashi, H. et al. 1998, *Science*, **281**, 1825 and erratum **282**, 1995